

Claims

- [c1] A method for storing a liquid into a geological formation using at least one well (62) penetrating into the geological formation, the geological formation comprising at least one storage zone, the method comprising:
 - providing a plurality of screens (61a, 61b, 61c), each screen being located alongside a wall of at least one well, and each screen respectively allowing a flow of liquid between an associated storage zone in contact with the screen and the well on which the screen is located;
 - controlling (68, 69) the flow of liquid through each one of the plurality of screens according to parameters providing from a storage model of the geological formation, the storage model describing a behavior of each storage zone.
- [c2] The method for storing according to claim 1, further comprising:
 - monitoring a quality parameter (TDS) of the liquid;
 - triggering a selecting step if the quality parameter reaches a critical value;
 - selecting a determined screen following the triggering;
 - modifying the flow of liquid through the determined screen.
- [c3] The method according to claim 2, further comprising:
 - providing the plurality of screens, each screen being located alongside the wall of a single well.
- [c4] The method according to claim 3, further comprising:
 - extracting the liquid from the geological formation;
 - monitoring the quality parameter of the liquid at an exit of the single well;
 - selecting an open screen following the triggering, the open screen being located as the deepest open screen alongside the single well among all open screens of the plurality of screens;
 - stopping the flow of liquid through the selected open screen.

- [c5] The method according to claim 4, further comprising:
 - positioning a seal inside the single well in proximity of the selected screen, to stop the flow of liquid through the selected screen.
- [c6] The method according to claim 3, further comprising:
 - extracting the liquid from the geological formation;
 - monitoring the quality parameter of the liquid at each screen of the plurality of screens;
 - selecting an open screen following the triggering, the screen corresponding to a location alongside the single well at which the quality parameter reaches the critical value;
 - stopping the flow of liquid through the selected open selected screen.
- [c7] The method according to claim 6, further comprising:
 - activating a closing mechanism at the selected screen, to stop the flow of liquid through the selected screen.
- [c8] The method according to claim 3, further comprising:
 - injecting the liquid into the geological formation through a first screen, the first screen being located as the deepest screen alongside the single well;
 - monitoring the quality parameter of liquid at an outside part of each screen of the plurality of screens distinct from the first screen, the outside part being in contact with a storage zone;
 - selecting a second screen among the plurality of screens following the triggering, the second screen being distinct from the first screen, and the second screen corresponding to a location alongside the single well at which the quality parameter reaches the critical value;
 - enabling the flow of liquid through the second screen.
- [c9] The method according to claim 2, further comprising:
 - providing a main well (112a);

providing at least one peripheral well (112b), the peripheral well being distinct from the main well;

providing at least one screen from the plurality of screens for respectively each one of the main well and the peripheral wells.

- [c10] The method according to claim 9, further comprising:
 - injecting the liquid into the geological formation through a screen located alongside the main well;
 - monitoring the quality parameter of liquid at an outside part of each screen located on a peripheral well, the outside part of each screen being in contact with a storage zone;
 - following the triggering, selecting a screen at which the quality parameter reaches the critical value;
 - injecting the liquid into the geological formation through the peripheral well on which the selected screen is located.
- [c11] The method according to anyone of claims 1 to 10 wherein:
 - the liquid is fresh water;
 - the geological formation is an aquifer;
 - the quality parameter is a total dissolved salt parameter.
- [c12] An apparatus for storing a liquid into at least one storage zone of a geological formation, the apparatus comprising:
 - at least one well penetrating into the geological formation;
 - a plurality of screens (51a, 51b, 51c), each screen being located alongside a wall of at least one well, and each screen respectively allowing a flow of liquid between an associated storage zone in contact with the screen, and a well on which the screen is located;
 - controlling means to control the flow of liquid through each one of the plurality of screens according to parameters providing from a storage model (54) of the geological formation, the storage model describing a behavior of each storage zone.

[c13] The apparatus of claim 12, further comprising :

- a main well (112a);
- at least one peripheral well (112b), the peripheral well being distinct from the main well;
- a sensor system respectively for each peripheral well, the sensor system measuring a value of a quality parameter over the liquid in an associated storage zone of a screen located on the peripheral well.

[c14] The apparatus of claim 13, further comprising:

- a first pump for injecting the liquid into the main well;
- a second pump for injecting the liquid into a peripheral well;
- processing means receiving a signal from the sensor system;
- wherein the controlling means are triggered to initiate the second pump for a determined peripheral well if the processing means output a signal indicating that the quality parameter at a screen of the determined peripheral well reaches a critical value.

[c15] The apparatus of claim 12, further comprising:

- a main well;
- at least one peripheral well, the peripheral well being distinct from the main well;
- a measuring device to measure a quantity of liquid that passes through the main well and the quantity of liquid that passes through each one of the peripheral well;
- wherein the controlling means receive a signal from the measuring device and control the flow of liquid according to the signal from the measuring device correlated to the storage model.

[c16] The apparatus of claim 12, wherein the plurality of screens (81a, 81b, 81c, 81d) is located alongside a wall of a single well (82).

[c17] The apparatus of claim 16, further comprising:

a sensor system to measure a quality parameter of the liquid at an exit of the well.

- [c18] The apparatus of claim 16, further comprising:
 - a sensor system (86a, 86b, 86c, 86d) respectively for each screen, the sensor system allowing to measure a quality parameter of the liquid flowing through the screen.
- [c19] The apparatus according to any one of claims 17 or 18, further comprising:
 - a seal allowing to isolate a portion of the well that is located below the seal from a portion of the well that is located above the seal;
 - operating means for catching and moving the seal inside the well.
- [c20] The apparatus of claim 19, further comprising:
 - processing means receiving a signal from a sensor system;
 - wherein the controlling means are triggered to initiate the operating means if the processing means output a signal indicating that the quality parameter passes a critical value, allowing to stop the flow of the liquid through a screen located below the seal.
- [c21] The apparatus according to any one of claims 17 or 18, further comprising:
 - a closing mechanism respectively for each screen to stop the flow of liquid through the screen.
- [c22] The apparatus of claim 21, further comprising:
 - processing means receiving a signal from a sensor system;
 - wherein the controlling means are triggered to initiate a determined closing mechanism if the processing means output a signal indicating that the quality parameter passes a critical value.
- [c23] The method according to claim 2, further comprising:
 - injecting the liquid into the geological formation;
 - extracting the liquid from the geological formation;

the selecting and the modifying being performed such as to keep the quality parameter of the liquid being extracted in a desired range;
interrupting the extracting of the liquid if the quality parameter is outside of the desired range.

- [c24] The method according to claim 23, wherein the injecting, the extracting and the interrupting are repeated in at least one cycle following the interrupting.
- [c25] The method according to anyone of claims 23 or 24, wherein the interrupting comprises selectively interrupting the extracting from one determined storage zone of the geological formation if the quality parameter from liquid extracted out of the determined zone is outside the desired range.